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FILING RECEIPT

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Applicant(s)

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**** SMALL ENTITY ****

Title

Robotic package unloading machine

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Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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Invention Disclosure: **Robotic Package unloading machine**

Background: There are many applications in general field of material handling where individual items must be unloaded from a larger unit holding multiple items. Common examples would include unloading packages from a pallet, unloading packages from inside a shipping container, picking items from a bin, or removing items from a case.

This "picking" process can be very labor and frequently it is the only manual process in an otherwise automated material handling system. Several efforts have been made to use Robotic type manipulators to perform the picking process and there has been some success in specific applications. The cost and complexity of these systems can vary widely. The mix of product and the level of organization in the bulk packaging are key factors.

Simpler solutions can be applied to situations where the product is uniform and where it is precisely located and organized within the bulk package. In these cases the robot can be pre-programmed to move to specific places and the robot end-of-arm-tooling (EOAT) can be designed to grip the product in a very predictable manner. These solutions are less complex and less expensive.

More complex solutions are needed when the product is not uniform and where its orientation or even its presence is unknown. In these cases the robotic manipulator needs to be highly adaptable. The system will be required to determine the presence and orientation and perhaps differentiate between different types of packages. This can be attempted with a combination of sensors, processing power, and software algorithms. Sensors systems such as vision, structured light, 3 dimensional imaging, sonic distance measuring, etc. can be used to collect data which is processed to attempt to determine the location, identity, and orientation of packages. Then the manipulator is controlled to reach the package and grip it with the EOAT. This tooling must also be more complex since it is required to securely grip different packages, in unique orientations, in an unpredictable manner. These types of solutions can be very complex, expensive, and frequently not possible with conventional technology.

The subject of this invention is a unique design for a robotic unloading system where a combination of active mechanical components simplifies the technical requirements for unloading non-uniform and non-structured bulk packages. With this approach more complex unloading problems can be accomplished with a simpler, less complex, and less expensive machine.

Invention: This invention presents a design for a robotic unloading system that could be used to unload packages from containers. In the basic configuration a robotic manipulator is coupled with a vision system and powered conveyor belt. The robot and vision system are used to identify packages and determine presence and orientation. A conveyor belt is positioned in close proximity to the package being removed. The robot and EOAT are used to move the package only a short distance to where the conveyor belt will catch the product and carry it away. The greatly simplifies the system design since the robot does not need the precision to securely lift and carry the package. The robot only needs to move the package onto the conveyor which is actively and advantageously positioned for each package removal action. The robot and conveyor work together to simplify the unloading process. The robot is only used to move product onto the conveyor.

Many different implementations of the basic configuration are possible and anticipated. The following sections show how this approach can be applied to a real-world unloading application typical of what is performed by Postal Mail Handlers when they unload mail trays from mail transport containers.
Figure (1) illustrates one embodiment of the robotic unloading system. The robotic manipulator (1) is mounted in a carriage (2) which can be raised or lowered in the carriage lift frame (3). The robot is

equipped with an end of arm tool (4) which is designed to grip the type of packages expected. The motor and drive mechanism (5) of the carriage lift frame provides the motive power to position the carriage at the correct height for unloading packages (6) from container (7).

The moving carriage incorporates a short takeaway conveyor belt (8) which moves with the carriage. Connected to the short takeaway belt is an articulating belt conveyor (9) which is connected to the moving carriage on one end and connected to the fixed take away conveyor (10) on the other end. The entire unloading mechanism is protected with a safety enclosure (11) to protect surrounding personnel from the moving equipment. A computer (12) provides the processing power to control the robot, the lift mechanisms, and the image/sensors (13) used to identify and locate packages inside the containers.

In operation the container (7) is positioned in front of the automated unloading system. Positioning could be manual or there could be some type of container feed system for automatic induction to the process. Once positioned the carriage (2) would raise in the carriage lift frame (3) and a image/sensor system (13) will scan the container contents. A computer processor (12) will use a processing algorithm to interpret the sensor data and determine the location of packages for unloading. The carriage lift drive system (5) will move the carriage to a appropriate elevation where the self contained takeaway belt (8) is positioned just below the package layer. The processor (12) will provide the robot manipulator with position and path data so that it can activate its arm movement and grip the package with a variety of preprogrammed strategies. The robot will acquire the package with its end-of-arm-tooling (4) and pull the package outwards until it makes contact with the takeaway belt (8). Once the package makes contact with the takeaway belt, the robot will release the package and let it be carried away to the articulating belt (9) which in turn will carry the package to the fixed takeaway conveyor (10) of the facility material handling system.

Having completed the removal of all packages on a single layer, the carriage will lower until new packages are sensed by the sensor system. Once there position is determined by the processor and the robotic process will be repeated. This sequence will be repeated until all layers of the container are unloaded and the container is empty. Then the operators will position a new container or an automated feed system will index a new container into position for automatic unloading.

Conclusion: The design of this unloading system utilizes standard mechanical components in a way the greatly simplifies the potential complexity of performing an automatic package unloading system.

The use of a movable takeaway conveyor in coordination with the dynamic positioning of the robot manipulator allows the use of a simpler end of arm tool and package acquisition strategy. Packages do not have to be lifted or held, they can be simply dragged or pushed onto the takeaway conveyor. Great precision is not required for either path planning or package gripping. Processing speed is also enhanced since the manipulator does not carry the package any distance. Robot moves are limited to a relatively small area with the actual transport of packages being performed by the conveyor. Different products, mixtures, or configurations can be accommodated with updates to the software based algorithms.

Many variations of this basic design and geometry are possible and anticipated. However the basic configuration and process described in this invention can provide robust and cost effective solutions to a great variety of automated unloading applications.

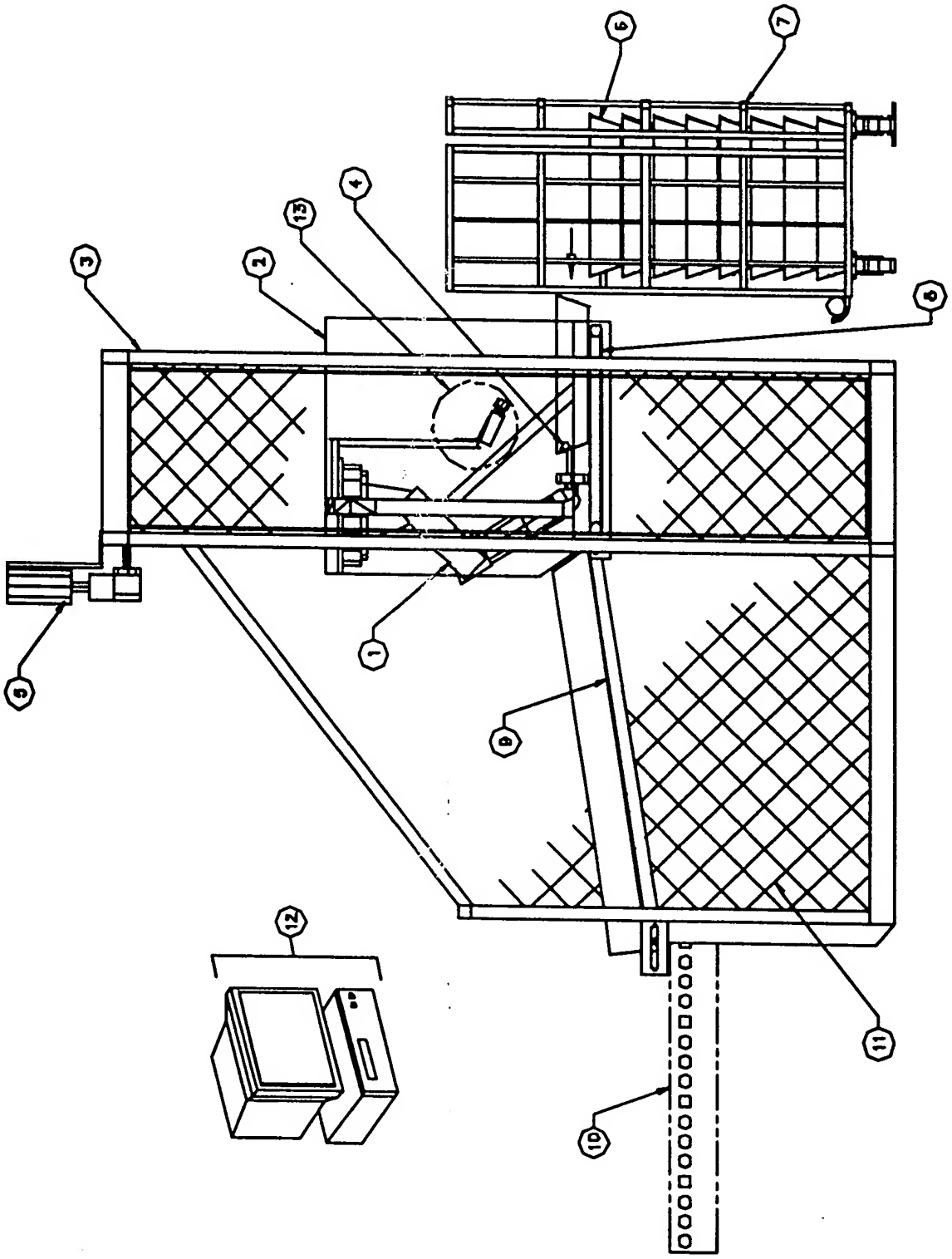

Figure 1